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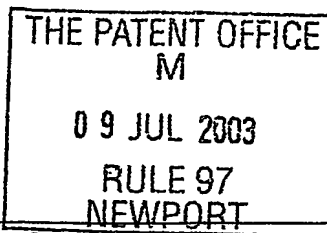


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P01/7700 0.00-0316160.1

9 JUL 2003

# Request for grant of a patent

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Cardiff Road  
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1. Your reference 0300190

2. Patent application number  
(The Patent Office will fill in this part) 0316160.1

3. Full name, address and postcode of the or of each applicant (underline all surnames)  
SMITHS GROUP PLC  
765 FINCHLEY ROAD  
LONDON  
NW11 8DS

Patents ADP number (if you know it) 8032310001 08461352001

If the applicant is a corporate body, give the country/state of its incorporation GB

4. Title of the invention  
SYRINGE PUMPS

5. Name of your agent (if you have one) J. M. FLINT

"Address for service" in the United Kingdom to which all correspondence should be sent (including the postcode)  
765 FINCHLEY ROAD  
LONDON  
NW11 8DS

Patents ADP number (if you know it) 1063304001 ✓

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and (if you know it) the or each application number	Country	Priority application number (if you know it)	Date of filing (day / month / year)

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application	Number of earlier application	Date of filing (day / month / year)

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? (Answer 'Yes' if:

a) any applicant named in part 3 is not an inventor, or

b) there is an inventor who is not named as an applicant, or

c) any named applicant is a corporate body.

See note (d)) YES

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Continuation sheets of this form

Description

Claim(s)

Abstract

Drawing(s)

9 /  
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10. If you are also filing any of the following, state how many against each item.

Priority documents

Translations of priority documents

Statement of inventorship and right to grant of a patent (Patents Form 7/77)

Request for preliminary examination and search (Patents Form 9/77)

Request for substantive examination (Patents Form 10/77)

Any other documents (please specify)

11. I/We request the grant of a patent on the basis of this application.

Signature

J. M. FLINT

Date 8 JULY 2003

12. Name and daytime telephone number of person to contact in the United Kingdom

J. M. FLINT

020 8457 8220

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## SYRINGE PUMPS

This invention relates to syringe pumps.

Syringe pumps are used to administer liquid medication to a patient at a precisely controlled rate. A syringe is filled with medication and is connected to a catheter. The syringe is then loaded into the pump and its plunger is gripped by a pusher mechanism, which is moved forwardly to push in the plunger and dispense the medication. Usually, the pusher is moved forwardly by means of a leadscrew rotated by a motor.

It is known in such pumps to have some arrangement for measuring the diameter of the syringe barrel so that the size of the syringe can be determined. The pump displays an indication of the syringe size for the user to confirm that this is correct. This information is then used in controlling the rate at which medication is dispensed. An example of a syringe barrel size measuring arrangement is described in GB2350062 where a strip coupled with an arm that bears on the syringe barrel moves along a CCD array of over a hundred elements. The strip has apertures of different lengths and, by measuring the position and length of the apertures, it is possible to obtain a very accurate indication of the diameter of the syringe barrel. Although this arrangement is very accurate it is relatively expensive and requires calibration, which does not make it suitable for low cost pumps. Alternative, low cost, arrangements involve a flag moving along a row of typically three sensors so that an increasing number of 1, 2 or 3 sensors are obscured as the flag moves. This arrangement gives an approximate indication of size but it does not enable the pump to distinguish between many different syringes.

Syringe pumps also commonly have some arrangement for detecting that the head of the plunger has been correctly retained by the pusher. This is important because, if the plunger is not retained, it is possible that it could move forwardly along the barrel and allow medication to siphon out of the syringe. The usual arrangement for detecting the presence of the plunger head is some form of electrical switch or pressure sensor in the pusher, such as described in GB2368288. Although this arrangement can function satisfactorily, it involves electrical connection being made to the movable pusher, which can cause problems, especially because the pusher may be exposed to liquid.

It is an object of the present invention to provide an alternative syringe pump.

According to one aspect of the present invention there is provided a syringe pump including a pusher mechanism for pushing the plunger of a syringe forwardly to dispense medication to a patient, the pusher mechanism including a member displaceable laterally of the direction of travel of the pusher mechanism when the pusher mechanism engages the syringe plunger, and elongate switch means extending parallel to the direction of travel of the pusher mechanism so that the switch means is actuated by the member when the pusher mechanism engages the plunger at locations along the travel of the pusher.

The pump preferably also includes second switch means operable when the pusher mechanism moves towards its forward position to provide a nearly-empty output. The switch means are preferably membrane switches.

According to another aspect of the present invention there is provided a syringe pump including a syringe barrel size sensor mechanism including a movable member mounted for contact with the syringe barrel, a plurality of sensor means and a plurality of flags, the movable member being arranged to effect relative movement between the flags and the sensor means, each sensor means being responsive to a flag to provide a first or second output according to the position of the flag relative to the sensor means, the flags and sensor means being arranged such that the output of at least one sensor changes from said first to said second and then back to said first state for relative movement between the flags and sensor means in one direction.

According to a third aspect of the present invention there is provided a syringe pump including a syringe barrel size sensor mechanism including a movable member mounted for contact with the syringe barrel, a plurality of sensor means and a plurality of flags, the movable member being arranged to effect relative movement between the flags and the sensor means, each sensor means being responsive to a flag to provide a first or second output according to the position of the flag relative to the sensor means, the flags and sensors being arranged such that the movable member is movable between a position in which a sensor means is exposed on one side of a flag, through a second position where the flag is aligned with the sensor means to a third position where the sensor means is exposed on an opposite side of the flag.

The flags are preferably mounted with the movable member, the sensor means being fixed with the pump housing. The movable member preferably includes an arm pivotally mounted at one end and having its other end arranged to contact the syringe barrel. The

sensor means may be optical. The pump may have three sensor means and three flags. The movable member preferably has an overcentre action.

A syringe pump according to the present invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is an elevation view of the front of the pump;

Figure 2 is perspective view of the rear of the pump with a part of its casing removed;

Figure 3 is a perspective view from the rear showing parts of the pump pusher mechanism;

Figure 4 is an elevation view of the rear of barrel size sensor mechanism; and

Figure 5 is a perspective view of the barrel size sensor mechanism.

With reference first to Figures 1 and 2, the pump has a generally rectangular shape with a substantially flat front face 1 supporting various controls 2 and a display 3. The rear surface 4 is also substantially flat and may have formations (not shown) for supporting the pump in a horizontal attitude.

The upper surface 61 of the casing 7 supports a conventional syringe 8 beneath a cover 5 hinged at its right-hand end 6 on the casing. The syringe 8 is shown with its plunger 81 in an extended position relative to the barrel 82, that is, with the syringe full of medication. The head 85 of the plunger 81 is gripped by a plunger pusher mechanism indicated generally by the numeral 86 and shown in more detail in Figure 3. The parts of the pusher mechanism 86 that grip the plunger head 85 have been omitted from Figure 3 for clarity. The pusher mechanism 86 is moved by a lead screw 88 extending lengthwise of the casing 7 and rotated axially by means of a motor (not shown) in the usual manner. The pusher 86 has an aperture 91 through which a guide rod 102 extends parallel to the lead screw 88. The guide rod 102 prevents rotation of the pusher 86 and ensures that rotation of the lead screw 88 is translated entirely into axial movement of the plunger 81, thereby ensuring accurate medication delivery.

A spring-loaded peg 120 projects from the forward surface 121 of the pusher mechanism 86 so that this engages and is pushed rearwardly by contact with the rear surface of the head 85 of the plunger 81 when this is correctly captured by the pusher mechanism. The peg 120 is coupled within the mechanism 86 to a laterally-extending rod 122 extending at right angles to the direction of travel, towards the front face 1 of the pump. The outer end 123 of the rod 122 is rounded and aligned with an aperture 124 in the side 125 of the pusher mechanism 86. With the peg 120 in its natural, extended position shown in Figure 3, that is, with no plunger head retained, the end 123 of the rod 120 is level with the side 125 of the pusher mechanism. When the peg 120 is pushed in by engagement with the plunger 81, the rod 122 is pushed laterally outwardly so that its end 123 projects a small distance through the aperture 124.



The side 125 of the pusher mechanism 86 moves along a panel 126 extending along the inside of the front face 1 of the pump. The inner surface 127 of the panel 126, that is, the surface adjacent the pusher mechanism 86, supports two membrane switches 128 and 129. The first membrane switch 128 takes the form of an elongate narrow strip of constant width extending horizontally parallel to the direction of travel of the pusher mechanism. The first switch 128 is positioned vertically so that it aligns with the upper part of the aperture 124 in the pusher mechanism 86. The second switch 129 is located below the first 128 towards its right-hand, forward end. The second switch 129 has an operative contact region 130 about three times the width of the first switch 128 and a length of about 20mm. The contact region 130 connects with a thinner track 131 extending rearwardly and spaced below the first switch 128. The dispositions of the first and second switches 128 and 129 are such that the first switch will be contacted at any point along its length by the end 123 of the rod 120 when this is pushed out by engagement with the plunger 81. The force with which the rod 120 is pushed out is sufficient to ensure that the switch 128 is turned on. The contacting surfaces of the rod 120 and switch 128 have a low friction so there is little resistance to forward movement of the plunger mechanism 86. As the pusher mechanism 86 moves forwardly, the end 123 of the rod 120 slides along the switch 128 keeping it on for as long as the plunger 81 is correctly engaged with the pusher mechanism. The end 123 of the rod 120 is spaced above the track 131 of the second switch 129 for all rear positions of the pusher mechanism 86 so that the second switch remains off. When the pusher mechanism 86 approaches close to the limit of its forward travel, the end 123 of the rod 120 contacts the rear end of the enlarged contact region 130 of the second switch 129, thereby turning it on and providing an output indicative

that the syringe 8 is nearly empty. The second switch 129 remains on as the pusher mechanism 86 moves forwardly along the length of the contact region 130.

This arrangement enables an output indication to be provided indicative of both plunger capture and a near empty syringe without the need for any electrical connection to the moving components. The membrane switches 128 and 129 are completely enclosed electrically so are not damaged by contact with fluid.

With reference now also to Figures 4 and 5, the pump has a syringe size sensor 200 including an arm 201 extending upwardly at an angle and hinged towards its lower end 202 about a horizontal axis. The arm 201 extends up the rear side of the syringe 8 and has a transverse finger 203 at its upper end extending forwardly above the barrel 82 at least across half the diameter of the barrel. An overcentre spring arrangement 204 urges the arm 201 anticlockwise, as viewed in Figures 2, 4 and 5, so that the finger 203 is urged down on the syringe barrel 82. The overcentre action enables the arm 201 to be retained in an open position by rotating it clockwise past a vertical position. The lower end 202 of the arm 201 is coupled with a sector plate 205, on the opposite side of the axis of rotation, which has a curved lower surface 206 supporting three flags 207, 208 and 209 spaced from one another along the lower surface. The flags 207 to 209 are provided by forwardly-projecting curved plates formed from the sector plate 205, which is of an opaque material. The two outer flags 207 and 209 are at the same radial distance from the upper, pivoted end of the sector plate 205 whereas the middle flag 208 is spaced radially outwardly by a short distance. The three flags are arranged to cooperate with three sensors 217, 218 and 219 respectively which are optical transmission sensors each having a slot 220 between an emitter and receiver. The

flags 207 to 209 are located to pass through the slot 220 of respective sensors 217 to 219 as the arm 201 rotates, thereby interrupting the optical path and changing the output of the sensor. The length of the flags 207 to 209 and their positions are such that the arm 201 is initially in a first position where at least one sensor is exposed on one side of a flag. Then the arm moves through a second position where the flag is aligned with and obscures the sensor, thereby changing its output. Continued movement of the arm moves it to a third position where the sensor is exposed on an opposite side of the flag. This thereby causes at least one of the sensors 217 to 219 to change state from an initial, to a second and then back to an initial state as the arm moves in one direction.

In particular, if the sensors 217, 218 and 219 are designated A, B and C respectively, as the arm 201 rotates clockwise when viewed from the rear of the pump, from the smallest syringe diameter to the largest, their outputs will be as follows:

A	B	C
1	0	0
1	1	0
1	1	1
0	1	1
0	0	1
0	0	0

It can be seen that both sensors B and C change from "0" to "1" and then back to "0" as the arm moves in one direction. This arrangement enables discrimination between six different angles of the arm 201. It will be appreciated, however, that it would be possible with

three sensors and three flags to have up to nine different sensor outputs, that is,  $3^2$ . In general, where  $n$  flags and sensors are used it would be possible to provide a maximum of  $n^2$  different outputs. The control unit of the pump readily converts the sensor outputs into an angle measurement and hence into a measurement of the diameter of the syringe barrel 82.

This arrangement enables the pump to distinguish between a greater number of diameters of syringe than would be possible using the same number of sensors in a conventional fashion. The arrangement, however, is low cost and does not require calibration.

The sensors need not be optical sensors but could, for example, be of a magnetic or any other suitable form.

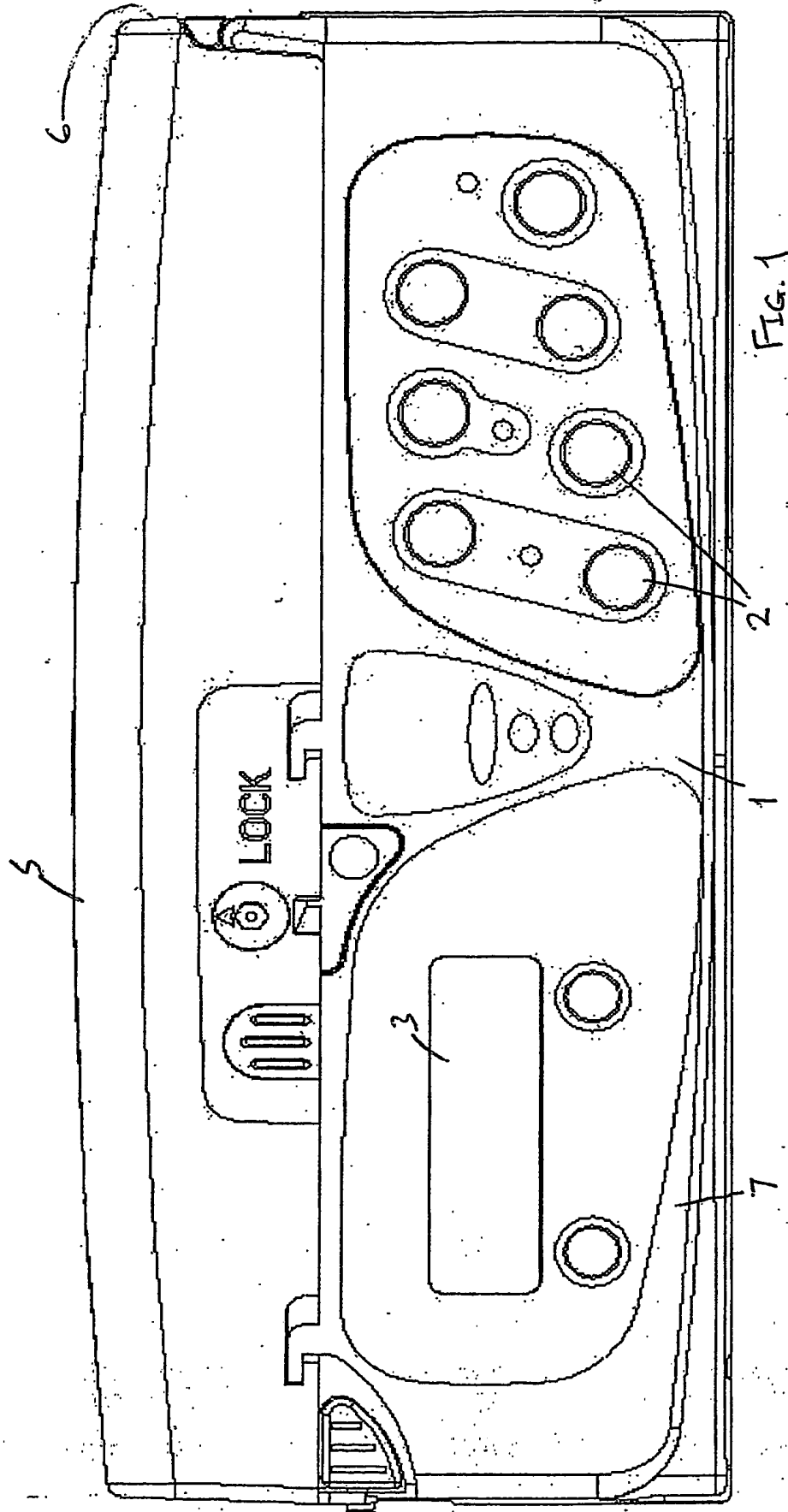


FIG. 1

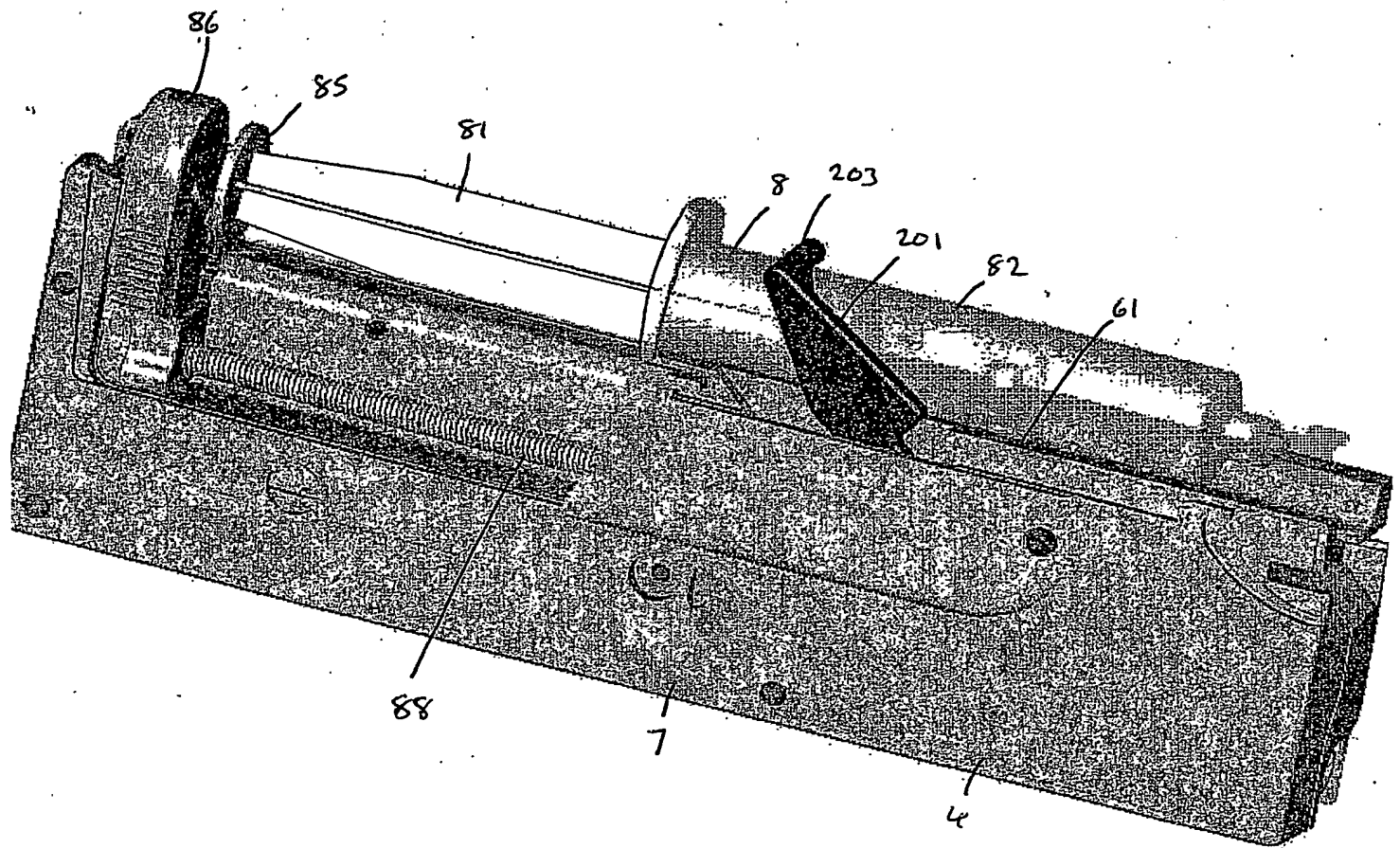
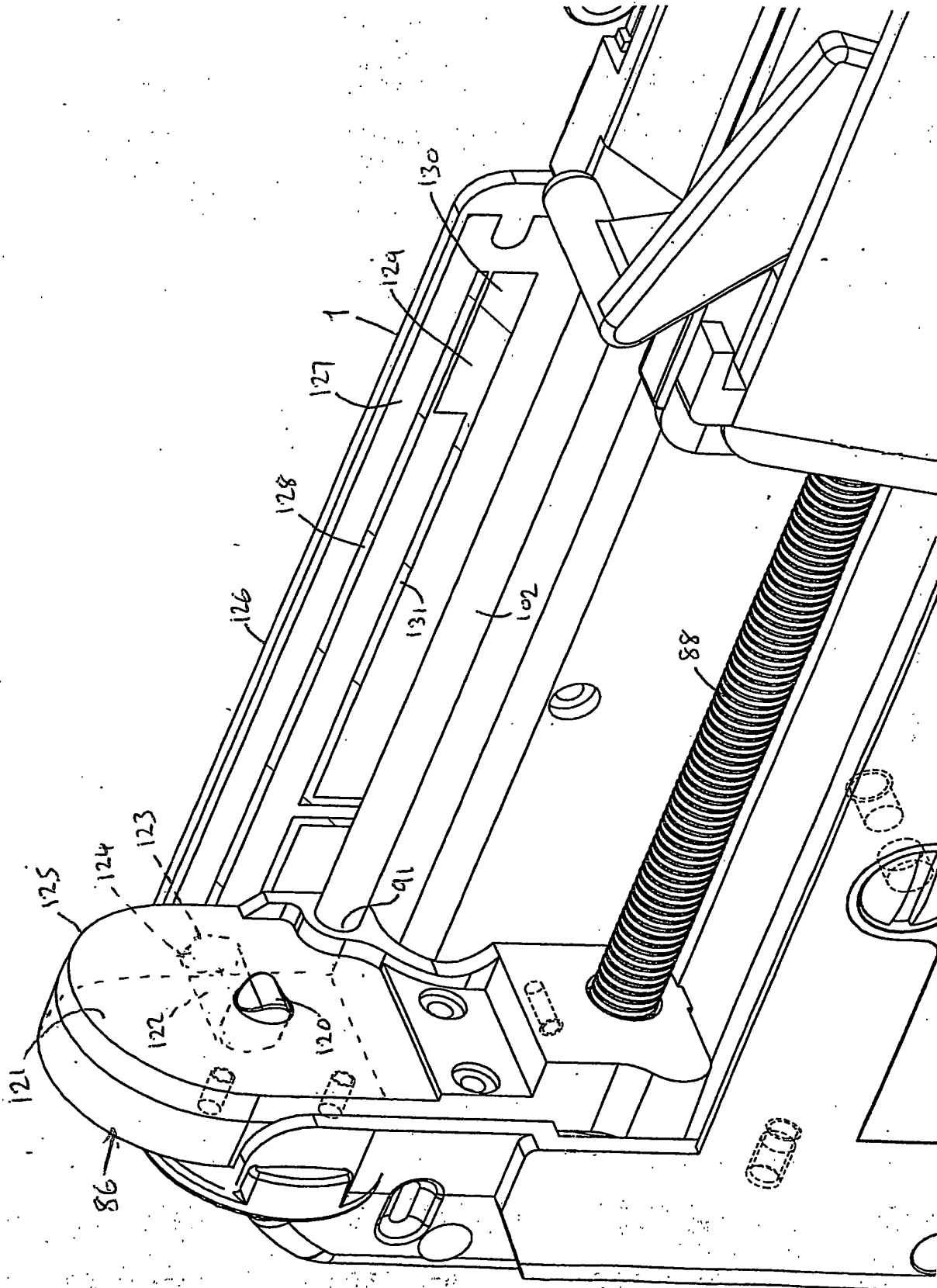


FIG. 2



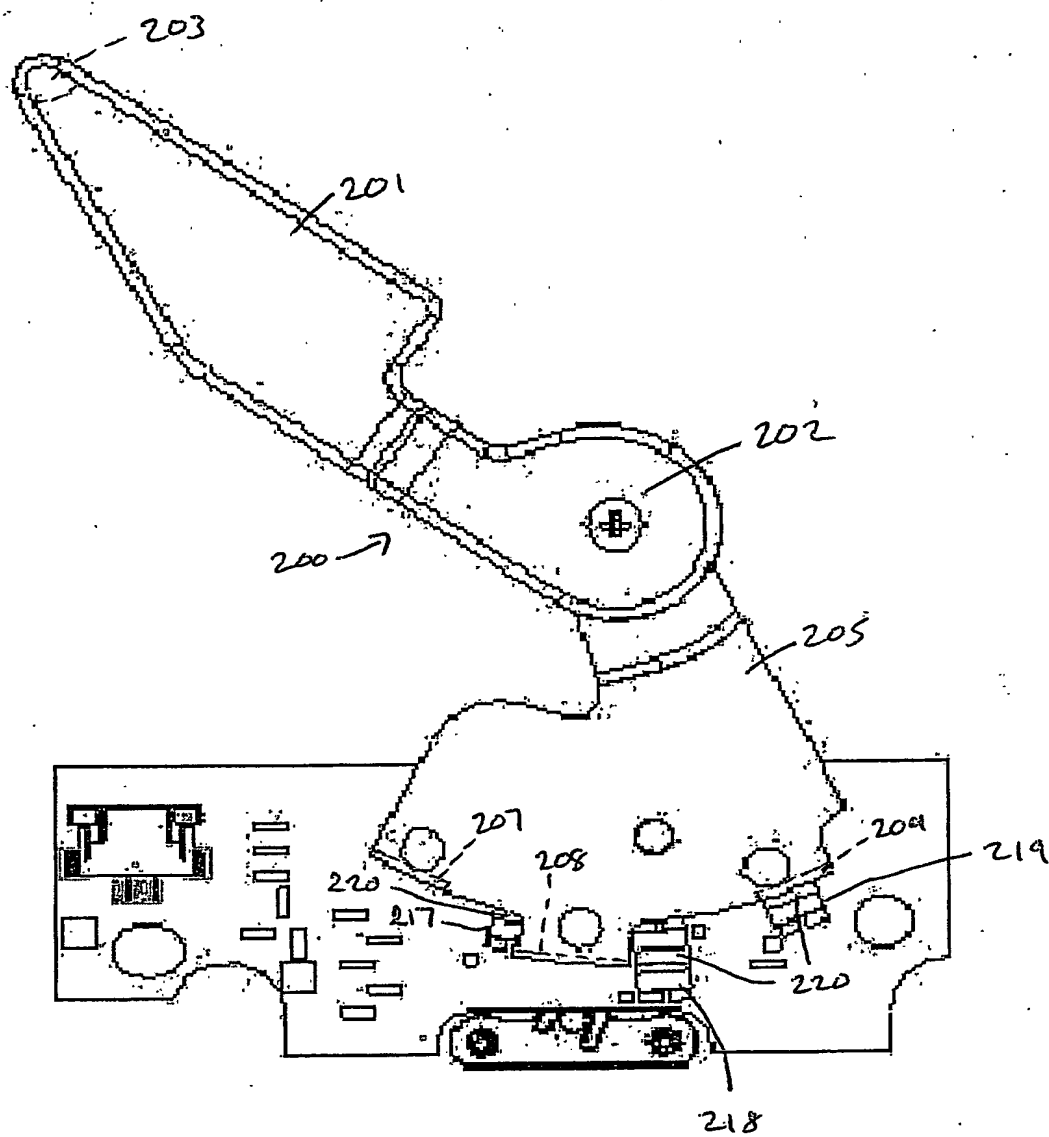


FIG. 4



SLS

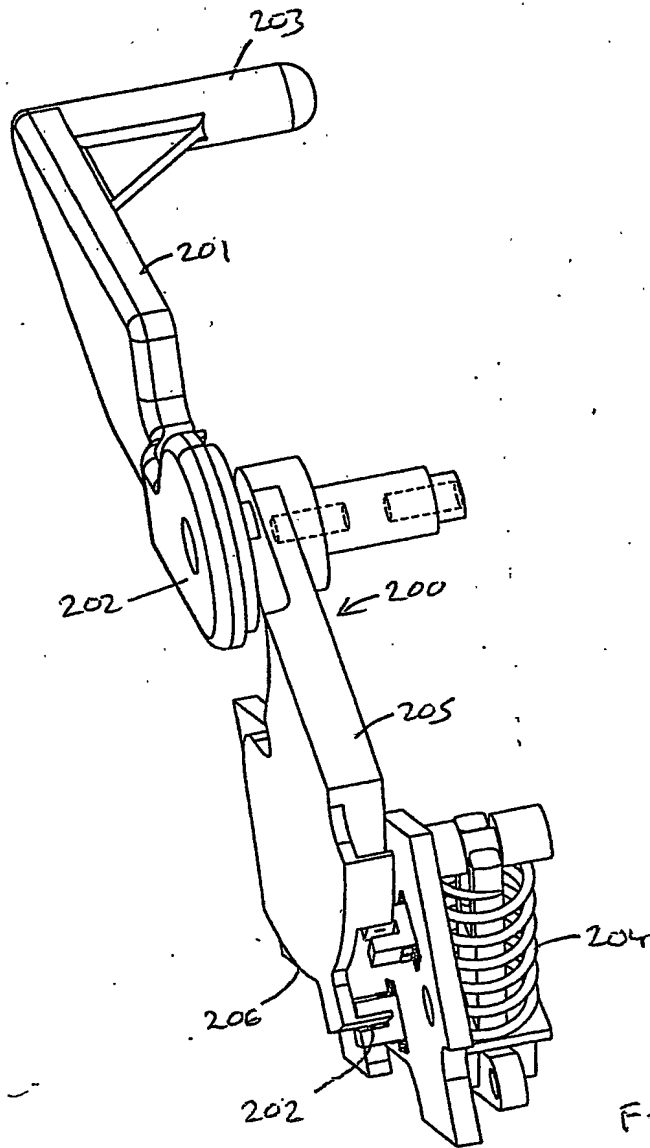


FIG. 5

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